should also, during the first and second year, work at mechanical drawing as provided for in the Art Directory, Stage 23*a*. *Third Year.*—The work of this year must depend so much on the student's aptitude, and the progress he has made in the preceding course, that it is impossible to lay down the subjects for the third year's course with any definiteness. It is essential that before continuing his course, or commencing new subjects, he should have a sound knowledge of the first stage of Mathematics, Elementary Mechanics, Physics, and Chemistry; that he should have such a knowledge of practical Geometry and Mechanical Drawing as to be able to draw and read simple plans, elevations, and sections with readiness, and that he should have sufficient facility in Freehand Drawing to make clear and neat explanatory diagrams.

When these subjects have been mastered, the student should, while continuing his studies in mathematics, take up the first stage of Animal Physiology, if he has not already done so. He will then be in a position to specialise his studies with advantage in one of the following groups, according to his requirements, taking up, for instance—1. Physics and Chemistry and Metallurgy; 2. Theoretical and Applied Mechanics, Steam, and Machine Construction and Drawing; 3. Theoretical and Applied Mechanics, and Building Construction and Drawing; 4. Biology; 5. Geology, Physical Geography, Mineralogy, and Mining. The student may also with advantage continue his freehand drawing and practical geometry.

The foregoing course is framed to lay the foundation of a thorough and systematic scientific training. It must, however, be understood that this course, though strongly recommended for all those who can devote sufficient time to go through it, in no way supersedes or does away with the power of holding special classes in different subjects for those who have not these opportunities, or diminishes the aid at present offered to such classes.

The fact of the course being intended as a systematic training will also explain the omission of certain subjects which are not to be considered unimportant because they find no place in the course. Thus systematic Botany will be found of very great use as a preliminary to the study of natural science. As such it may be taught in elementary schools before this course is commenced. But, further than that, it cannot be considered a step in a systematic course till the student takes it up as a portion of Biology in his third year. In the same way Physical Geography is a subject which may with great advantage be studied in all schools, and is especially adapted for students who cannot go through a systematic course. The first elements of Physical Geography, treating broadly the outlines of physical science and describing its objects, should, as stated above, be taught as an introduction to its systematic study. But Physical Geography in its general sense covers so wide a field, embracing to a greater or less degree so many branches of Science, that it does not fall into a systematic course of training in science, though as a means of imparting highly valuable general information, as distinct from a systematic training, it may be strongly recommended.

ARCTIC EXPLORATIONS

AN excellent paper on the above subject appears in NATURE of Nov. 30, and it is to be hoped that it may have the desired effect of reanimating in our Government and among scientific men a fresh interest in the prosecution of a further survey of the unknown seas round the Pole.

Agreeing as I do with the writer as to the great importance of such an exploration as he recommends, I cannot so readily acknowledge the correctness of his opinion as to the advantages of the route by Smith Sound over that along the west shore and to the north of Spitzbergen, from which point Parry (the greatest and noblest of arctic explorers) attempted to reach the Pole with boat sledges in 1827.

Parry had, I think, on this occasion chosen the right route, but the wrong season of the year; for he attempted the journey in the month of July, instead of in March, April, May, and June.

At Spitzbergen a vessel can always get as far as 80° north, probably higher; for Mr. Lamont has, during the last two summers, on his pleasure cruises, readily reached the latitude named.

I had it from the great navigator Parry himself, that the ice he saw to the north of Spitzbergen would not have been difficult to travel over at the proper season of the year.

The farthest north point reached with much difficulty by ships in Smith Sound has been 78°40′, and we have not the least warrant or certainty that any future expedition may be able to winter its ship or ships nearer the Pole by this route.

From lat. 78°40′ the distance to the Pole is 680 geographical miles, making the journey there and back 1,360 miles in a straight line.

But surely no experienced Arctic traveller would be sanguine enough to believe that he could take a "bee line" in a sledge journey to the Pole; in fact, he would require to make an allowance of about one-fifth for obstructions by rough ice, probable contour of coast line, &c., so that the actual distance to be made would be 1,360 + 270 = 1,630 geographical miles, a journey 200 or 300 miles longer than any that has yet been accomplished, even by that admirable Arctic traveller, the late Lieut. Mecham. Yet Mecham, in his two longest journeys of 1,200 or 1,300 miles each (I forget whether these are geographical or statute miles, but I think they are the latter), had advantages not likely to be found in a journey to the Pole. On the one occasion deer, musk-cattle, and other game were so abundant and so tame that he could and did easily kill as many as the party required, and could have killed many more. On the other occasion he was travelling along a known route, at several points of which depots of provisions had been placed by ships wintering there, or by other means, from which he was enabled to obtain supplies both on the outward and homeward march.

Mr. Markham says that a ship can always get so far north in Smith Sound that the Pole can be reached by a journey from it with sledges of 968 miles there and back.

By what powers of reasoning or rule of arithmetic this conclusion has been arrived at I am at a loss to know, unless there is always a certainty of ships getting into winter quarters in Smith Sound as far up as 82° latitude, yet Kane was stopped 200 miles south of this, and Hayes even at a greater distance.

The Spitzbergen route has never had a fair trial with sledges over ice either with or without the aid of dogs, and I believe that if the Pole is ever to be reached, it will be by it, and not by Smith Sound. The distance to be travelled will not probably be less than 1,400 geographical miles, possibly more, a journey practicable enough under favourable circumstances, but by no means easy of accomplishment.

JOHN RAE

NOTES

AT the Anniversary Meeting of the Fellows of the Royal Society on Thursday last, Lieut.-General Sir Edward Sabine, R.A., K.C.B., resigned the office of president, which he has filled since 1861, and the Astronomer Royal was elected to fill the presidential chair. The following gentlemen were appointed officers and council for the ensuing year:—President: George Biddell Airy, M.A., D.C.L., LL.D., Astronomer Royal. Treasurer: William Spottiswoode, M.A. Secretaries: William Sharpey, M.D., LL.D.; Prof. George Gabriel Stokes, M.A., D.C.L., LL.D. Foreign Secretary: Prof. William Miller, M.A., LL.D. Other Members of the Council: George J. Allman, M.D.; John Ball, M.A.; George Burrowes, M.D.; George Busk, P.R.C.S.; Prof. Robert B. Clifton, M.A.; H. Debus, Ph.D.; Prof. P. M. Duncan, M.B.; Prof. G. Carey Foster, B.A.; Francis Galton; Thos. A. Hirst, Ph.D.; Sir John Lubbock, Bart.; Sir James Paget, Bart., D.C.L.; The Earl of Rosse, D.C.L.; General Sir E. Sabine, R.A., K.C.B.; Isaac Todhunter, M.A.; Sir Charles Wheatstone, D.C.L. The President's annual address was occupied by a *résumé* of the most important advances in science, mainly physical, during the year. After alluding to the loss sustained by the Society in the deaths of Sir John Herschel, Mr. Babbage, and Sir R. Murchison, General Sabine referred particularly to the munificence of Mr. J. P. Gassiot, by which the Kew Observatory has been transferred to the Royal Society in trust, with an income of 500*l.* per annum towards the cost of carrying on and continuing magnetical and meteorological observations with self-recording instruments, and any other physical investigations that may from time to time be found practicable and desirable in the present building at Kew belonging to the Government; or, in the event of the Government at any time declining to continue to place that building at the disposal of the Royal Society, then in any other suitable building which the Council of the Royal Society may determine. The following papers and investigations were also specially named by the president:—"On the Dependence of the Earth's Magnetism on the Rotation of the Sun," by Prof. Hornstein, of Prague; the Pendulum Experiments in India, by the late Captain Basevi, R.N.; Mr. Ellery's report on the Great Melbourne Telescope; the Investigations of the Lunar Atmospheric Tide, by M. Bergsma, of Batavia; and the Memoir by Prof. Heer, of Zürich, on the Fossil Plants brought from Greenland by Prof. Nordenskiöld. The Copley and Royal medals were then awarded, as already noted.

With regard to the Australian arrangements for observing the Total Eclipse of Tuesday next, we learn that the Royal Society of Victoria (not of New South Wales, as had been previously reported) were up to the end of September making vigorous preparations for an Expedition, but that at that time they were afraid that their plans would be seriously frustrated by the failure of Government aid, which they had been led to expect would be liberally granted. Mr. Ellery, the president, and Mr. Rusden, the secretary of the Royal Society of Victoria, were exerting themselves to the utmost to secure the success of the Expedition, which was to start not later than November 22nd. By the most recent Melbourne papers of October 9 and 10, we learn that, notwithstanding the supineness displayed in the matter by the other Australian colonies, it was still hoped that the Government of Victoria would render such pecuniary assistance as would make it possible for the Expedition to set out with some chance of success in obtaining results of scientific value. The number of persons who had already agreed to join the expedition up to that date was twenty, of whom four or five were of Adelaide, three of Sydney, and one or two of Tasmania. No very certain information had been procured about the prevailing weather in the latitude where the eclipse will be visible. The destination of the steamer will be Cape Sidmouth, about midway between Cardwell and Cape York, where there is some risk of the weather being unfavourable, inasmuch as during December the N.W. winds frequently bring heavy rain. Probably the Expedition will be broken up into several observing parties, and two or more stationed at different points of the mainland, and one on a neighbouring island.

The elevation of Mr. W. R. Grove, Q.C., to the judicial bench is a noteworthy event in the history of the *personnel* of Science. It is well known that the author of the "Correlation of Forces," and *quondam* President of the British Association, is an authority of no mean rank on some of the most abstruse questions of law.

The Exhibition of Stone Implements (Neolithic and Savage) at the Apartments of the Society of Antiquaries in Somerset House will be open at the meeting of the Society this evening, and from the 8th to the 14th inclusive from eleven to four. Cards of admission may be obtained from the secretary.

We learn from Prof. H. A. Newton, of New Haven, Conn., that between 11·20 P.M. on November 13, and 1·45 A.M. November 14, ninety-eight meteors were seen, though the sky was cloudy. Not more than one-tenth of them were, however, regarded as belonging to the meteor stream of November. Prof. Newton thinks that if the earth met the stream this year, it was either before or after the interval of observation.

An application has been received by the Kew Committee of the Royal Society from Dr. Jelinek, Director of the "Central Anstalt für Meteorologie and Erdmagnetismus," to procure for that establishment a set of self-recording magnetographs similar to those at Kew. The request has been complied with; and it is hoped that the apparatus will be ready for transmission to Vienna in March next, being the time named by Dr. Jelinek as that at which the new building in course of erection in that city is expected to be completed. The Committee has also been apprised by a letter from Mr. Stone, Astronomer Royal at the Cape of Good Hope, that he had at that date applied to the Admiralty for a set of magnetographs, similar to those at Kew, to be employed at the Cape. The Kew Committee hold themselves in readiness to supply the desired apparatus when they may receive directions to that effect from the Admiralty; such directions, however, have not yet been received. If Mr. Stone's request is granted, the Cape Observatory will be the third in the British Colonial Dominions employing such instruments, the other two being the Colaba Observatory under Mr. Chambers at Bombay, and the Mauritius Observatory under Mr. Meldrum.

It is reported that the French Government intends to establish two schools, one at Lyons and the other at Nancy, in place of the Strasburg medical school. The Strasburg professors are to go to Lyons; and it is expected that that school will assume an important position in consequence of the large amount of hospital accommodation in the city. At Nancy, physics, chemistry and physiology will be more especially taught.

Harper's Weekly announces the death, in Boston, of the Rev. J. A. Swan, on October 31, at the age of forty-eight. Mr. Swan has been long known among his New England friends for his love of natural history and his skill in the use of the microscope; and during his residence at Kennebunk, although a devoted pastor in that village, he found time to make numerous important explorations and observations in the natural history of the vicinity. Failing in health a few years ago, he visited Europe, and on his return was appointed to the responsible post of secretary of the Boston Society of Natural History, in connection with Prof. A. Hyatt, succeeding Mr. Scudder in charge of the business of the society. Apart from his scientific accomplishments, Mr. Swan was endeared to all his friends by personal qualifications of the rarest merit.

The Society of the Friends of Science, in Posen, propose, on February 19, 1873, to celebrate the 400th birthday of the eminent astronomer, Nicholas Copernicus, at his birth-place, in the village of Thorn. In addition to the festivities of the occasion, they intend to publish an accurate biography of their countryman, and to prepare a monumental album, as also to strike an appropriate medal. A prize of 500 thalers is offered for the best biography that can be prepared before January 1, 1872, to be based only upon authentic documents.

WE have received the first number of "The German Quarterly Magazine; a Series of Popular Essays on Science, History, and Art." The plan of the publication is to give in English such essays, selected from the "Sammlung gemeinverständlicher wissenschaftlicher Vorträge," edited by Profs. Virchow and Franz von Holtzendorff, as are likely to interest the English reading public, and also original contributions; the numbers presenting alternately selections from the departments of Science, History, and Art. The present number contains three papers:—"The Cranial Affinities of Man and the Ape," by R. Virchow; "Sight and the Visual Organs," by A. von Graefe; and "The Circulation of the Waters on the Surface of the Earth," by H. W. Dove; all papers of great interest and importance, but losing something to the English reader from the German phraseology in which the translations are clothed. They are illustrated by good woodcuts, and the subscription to the magazine is 10*s.* per annum.

MESSRS. LONGMAN & CO. are about to publish a volume by Mr. Serjeant Cox, entitled "Spiritualism answered by Science," in which he will detail the arguments that satisfied himself and the other scientific investigators that the phenomena of alleged "Spiritualism" are purely physical, and in no manner associated with spirits of the dead.

DR. BESSELS, the director of the scientific corps of Captain Hall's steamer *Polaris*, in a letter addressed to the president of the American National Academy of Sciences, dated Godaven, August 16, states that he had already made some important observations in regard to the physics of the northern seas, such as a peculiar coloration of the water and an unexpectedly high specific gravity, the maximum density noticed being 1·028. His experiences with his colleagues, Mr. Bryan, the astronomer, and Mr. Meyer, the meteorologist, have been very satisfactory; the former gentleman having made a number of successful azimuth observations, and the latter approving himself an excellent mathematician and an accomplished observer, and an honour to the Signal Service, from which he was detailed for duty with Captain Hall.

THE recently published report of Commissioner R. W. Raymond upon statistics of mines and mining in the states and territories west of the Rocky Mountains for the year 1870, forms a stout volume of nearly 600 pages, illustrated by a number of plates and sections, embodying the result of a laborious personal examination, and that of several assistants. The report contains a detailed account of the present condition of the mining industry in California, Nevada, Oregon, Idaho, Montana, Utah, Arizona, New Mexico, Colorado, and Wyoming, together with interesting statements in regard to improved metallurgical processes, such as especially relate to the treatment of auriferous ores, the chlorination and smelting of silver ores, &c. There are also chapters on narrow-guage railways and their adaptation to mining regions, the mining law, the geographical distribution of mining districts, the origin of gold ingots and gold-dust, and the bullion product. The Commisioner congratulates the country upon an increased prosperity in the mining industry, as seen not only in an augmented bullion product, but an improved tone in the business itself, and relief from more or less of the irritating and burdensome questions that have hitherto been connected with the mining interest. Although the excitements which so frequently carry off the miners and settlers of one region into a new locality have been comparatively rare, yet there have been a few of special note. Among these mentioned by Mr. Raymond are those caused by the discovery of gold in Southern California, near San Diego; the discovery of silver in the Burro Mountains, and the rumours of rich placers on Peace River, far into the interior of British Columbia; the bars of Snake River; several localities in Nevada, and others in Utah; the silver mines in the Caribou district of Colorado, &c.

COLDING ON THE LAWS OF CURRENTS IN ORDINARY CONDUITS AND IN THE SEA

III.

LET us now direct our attention to the polar currents, and especially to that one which from Spitzbergen proceeds to the south-west along the coast of Greenland as far as Cape Farewell. It will be seen that this current has received an impulse from the force of rotation, and rises about one foot towards the west coast of Greenland, an effect which however ceases as soon as it has passed the southern point of that country. As soon as the resistance which compelled the current to follow the line of the coast in proceeding to the south-west disappears, it can no longer continue in the same course, but takes a westerly direction towards Labrador, partly in consequence of the rotation of the earth, partly because the level of the current is then higher than that of the waters of Davis Strait. After having advanced a little into the strait, the polar current encounters the currents coming from the north by Baffin's Bay, and joins them in their progress to the south-east along the coast of Labrador, towards which it slopes in virtue of the rotation of the earth. During this passage, and until its arrival in the neighbourhood of Newfoundland, this current is stemmed by the force of rotation, and ought, consequently, to present a slope all along Davis Strait and the east coast of Newfoundland as far as the Gulf Stream. During its course southwards along this course, the polar current is elevated towards the land by the earth's rotation; but as soon as it has passed Cape Race, this resistance suddenly disappears, and the same phenomenon is reproduced as at Cape Farewell. The current bends suddenly to the south-west, and follows the coast as far as Florida, while its breadth and the volume of its water continue to diminish.

From Newfoundland to Florida, a distance of about 500 miles, the Gulf Stream and the polar current flow constantly side by side, under the impulse of the earth's rotation, which raises the polar current towards the land and compels it to follow all the ins and outs of the coast. But what force is it that impels the Gulf Stream, which flows freely in the ocean, to keep by the side of the polar current in all its windings, instead of taking the more easterly direction, which the rotation of the earth tends to give it? It is, of course, gravity, to wit, the force resulting from the slope which the Gulf Stream presents from right to left perpendicular to its direction throughout its entire breadth, a slope which is 1·2 feet from the point where the current debouches into the Atlantic to New York, and about one foot from New York to the place where, after having approached the shores of Europe, it separates into two branches. And if it be asked why the Gulf Stream has this slope; the reason evidently is that the water of the polar current has a specific gravity greater than the water of the Atlantic, and ought consequently to have a lower level than that of the latter sea, since the water beneath is in equilibrium. That this is the real state of the matter is fully confirmed by the researches made in recent years in the Gulf Stream at the instigation of the American Government, and which leave no room to doubt that this current has not kept its place on account of the difference of density which exists between the waters of the polar current and those of the Atlantic. Under these circumstances it is easy to see that the Gulf Stream ought to follow all the sinuosities of the polar current as far as Newfoundland.

But while the Gulf Stream ought thus to be considered as presenting a uniform slope from the Atlantic towards the polar current, the researches undertaken by the American Government prove that the bottom of the Gulf Stream could be in equilibrium only if that current had an inclination directed away from the polar current towards the Atlantic, such that its maximum level would be nearly one-third of the distance from the polar current. Under the actual conditions, then, there is no equilibrium. The waters of the polar current exercise upon the Gulf Stream a pressure which increases with the depth, and causes a continual afflux of cold water, especially in its lower depth. In proportion as these cold waters penetrate into the Gulf Stream, it communicates to them its heat and its motion, and in proportion as it is raised under the influence of the pressure of the polar current driving away the water which it displaces, its breadth ought to go on increasing. But in order that the breadth of the Gulf Stream may increase, it is necessary that its level in the centre of the current be elevated above that which corresponds to the equilibrium of the surface, so that the force of